GHENT UNIVERSITY

Course Specifications

Valid in the academic year 2018-2019

Mathematic Models (E001161)

Course size (nominal values; actual values may depend on programme)

Credits	6.0	Study time	180 h
Contact hrs	60.0 h		

Course offerings and teaching methods in academic year 2018-2019

A (semester 1)	Dutch	seminar: practical PC room classes	15.0 h
		lecture	30.0 h
		lecture: plenary exercises	15.0 h

Lecturers in academic year 2018-2019

Constales, Denis	TW16	lecturer-in-charge

Offered in the following programmes in 2018-2019	crdts	offering
Bridging Programme Master of Science in Electrical Engineering (main subject Communication and Information Technology)	6	A
Bridging Programme Master of Science in Electromechanical Engineering (main subject Control Engineering and Automation)	6	A
Bridging Programme Master of Science in Electromechanical Engineering (main subject Electrical Power Engineering)	6	A
Bridging Programme Master of Science in Electrical Engineering (main subject Electronic Circuits and Systems)	6	A
Brugprogramma Master of Science in Bioinformatics (main subject Engineering)	6	A
Bridging Programme Master of Science in Electromechanical Engineering (main subject Maritime Engineering)	6	A
Bridging Programme Master of Science in Electromechanical Engineering (main subject Mechanical Construction)	6	A
Bridging Programme Master of Science in Electromechanical Engineering (main subject Mechanical Energy Engineering)	6	A
Bridging Programme Master of Science in Biomedical Engineering	6	A
Bridging Programme Master of Science in Biomedical Engineering	6	A
Bridging Programme Master of Science in Industrial Engineering and Operations Research	6	A
Bridging Programme Master of Science in Civil Engineering	6	A
Bridging Programme Master of Science in Chemical Engineering	6	A
Bridging Programme Master of Science in Civil Engineering	6	A
Bridging Programme Master of Science in Computer Science Engineering	6	A
Bridging Programme Master of Science in Computer Science Engineering	6	A
Bridging Programme European Master of Science in Photonics	6	A
Bridging Programme Master of Science in Photonics Engineering	6	A
Bridging Programme Master of Science in Fire Safety Engineering	6	A
Bridging Programme Master of Science in Industrial Engineering and Operations Research	6	A
Bridging Programme Master of Science in Sustainable Materials Engineering	6	A
Bridging Programme Master of Science in Materials Engineering	6	A
Bridging Programme Master of Science in Chemical Engineering	6	A
Preparatory Course Master of Science in Industrial Engineering and Operations Research	6	A
Preparatory Course Master of Science in Fire Safety Engineering	6	A
Preparatory Course European Master of Science in Nuclear Fusion	6	A

and Engineering Physics		A
Preparatory Course Master of Science in Engineering Physics	6	A

Teaching languages

Dutch

Keywords

Basic mathematical concepts, mathematical models for engineering applications, differential equations, boundary conditions

Position of the course

Basic mathematics and mathematical modelling play a prominent role in engineering. Mathematics brings a framework and structure for the quantitative treatment of problems originating in engineering practice, and mathematical modeling is the basis of most current technological innovations. It is a fundamental tool in many applications. The main purpose of this course is twofold: (1) repetition and / or deepening of some essential basic mathematical concepts, in particular in view of their usefulness in engineering practice, and (2) teaching of the basics for setting up a mathematical model.
The mathematical description of widely used models is based on vector calculus and differential equations: ordinary (ODEs) and partial (PDEs), which describe fundamental laws (e.g., laws of motion and conservation laws). Other models focus on the treatment of signals as information carriers and make use of complex functions, signal operations and transformations. These aspects are therefore discussed in detail.
The course is primarily aimed fr students who did not follow the bachelor study in Engineering and who do not possess the corresponding knowledge to follow a Master in Engineering

Contents

1 Models for discrete systems: algebraic structures:
   - number systems (naturals N, integers Z, rationals Q, reals R, complex C, quaternions H)
   - group, ring, vector space, (finite) field
   - polynomials, rational functions, conversion to partial fractions
   - matrix algebra, in particular linear operators, eigenvalues and eigenvectors, Jordan normal form, self-adjoint, normal, orthogonal and unitary matrices; rotations in 3D, exponential of a matrix, singular value decomposition, Moore-Penrose generalized inverse
2 Models for multidimensional systems: vector calculus:
   - Vectors, vector calculus (scalar product, vector product, mixed product, double vector product), curves in R^3.
   - Vector analysis: the nabla operator (as gradient, divergence and curl) and the Laplace-operator in Cartesian coordinates, scalar fields and vector fields, the theorems of Green, Gauss and Stokes
   - Modelling of forces, kinematics and dynamics of mechanical systems: rotation of a rigid body, torque, momentum
3 Models for dynamic behavior and distributed systems: differential equations
   - Linear differential equations with emphasis on the specific properties of solutions, the initial conditions associated to this problem; the harmonic oscillator
   - The basic types of linear partial differential equations (PDEs) of second order (heat rod, vibrating string, vibrating membrane, Laplace PDE) using the Fourier method (as a direct application of Fourier series)
4 Signal Models
   - Integral transforms (Fourier, Laplace, Z)
   - Models of information-bearing signals and their processing: signals, causal linear system, transfer function

Initial competences

The mathematics in the curriculum of bachelor of industrial sciences.

Final competences

1 To be familiar with the definitions, main characteristics and relevance originating from the mathematical concepts in Engineering.
2 To be able to apply the basic mathematical concepts inherent in the engineering sciences to simple examples (both theoretically as well as using software packages such as Maple and Matlab).
3 To be able to analyze the results obtained through mathematics.
4 To be familiar with the structure of mathematical models used in engineering practice. To be able to apply and build such models. To understand the strength and

also the limitations of these models.

Conditions for credit contract

Access to this course unit via a credit contract is determined after successful competences assessment

Conditions for exam contract

This course unit cannot be taken via an exam contract

Teaching methods

Lecture, lecture: plenary exercises, seminar: practical PC room classes

Learning materials and price

- Lecture notes (Dutch) through the VTK (ca. 5€)
- Maple worksheets/Matlab scripts will be distributed via Minerva (Dutch).
- Maple and Matlab are both available from the Athena platform.

References

- Textbook Mathematical analysis I, II and III, Geometry en linear algebra
- F. Ayres and E. Mendelson, Schaum's Outline of Calculus, 5th ed., ISBN 0071508619

Course content-related study coaching

- individual coaching by appointment
- interactive coaching via Minerva: Forum (students among themselves, students – lecturer)

Evaluation methods

end-of-term evaluation

Examination methods in case of periodic evaluation during the first examination period

Written examination with open questions

Examination methods in case of periodic evaluation during the second examination period

Written examination with open questions

Examination methods in case of permanent evaluation

Possibilities of retake in case of permanent evaluation

not applicable

Extra information on the examination methods

written examination with open questions: theory closed book, exercises with open book (theory lecture notes plus class notes) and PC.

Calculation of the examination mark

Distribution: Theory 8/20 + Exercises 12/20.